

CHAPTER X. GRASSLANDS

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EXECUTIVE SUMMARY

Grasslands are the most common vegetation type within the Area of Focus (AOF) and are found within the East Bay Stewardship Network Partner (Network) lands. Although grasslands in the region and throughout the state are dominated by non-native plant species, they support diverse ecosystems. Approximately 90% of species listed in the inventory of rare and endangered species in California occur within grasslands (Skinner and Pavlik 1994). Only a few grassland plant species have gone extinct in California; native species remain rich in number, even when their cover is low individually (Stromberg et al. 2007). Additionally, grasslands support birds, pollinators, and other wildlife that are dependent upon grasslands' low vegetative height and open structure, as well as the seed, pollen, and forage they provide. Grassland health is an indicator of the health of the plant and wildlife taxa it supports as well as soil and watershed health.

This chapter analyzes grassland health within the AOF and associated landscape units to be consistent with other chapters. These analyses were also conducted for all East Bay Regional Park District (EBRPD) lands, including those that occur outside of the AOF (see **Appendix A**). **Appendix A** also utilizes eight "grassland landscape units" that differ from the NatureCheck landscape units; these units better capture groups of homogenous grassland plant communities and ecosystems.

Three metrics were selected to assess the health of these grasslands: 1) Native grass and forb species cover and/or richness; 2) Spatial extent of grasslands; and 3) Patch size. These metrics were selected because there was adequate support in the literature for assigning values to meaningful, specific goals and thresholds that could be measured across time and space. Although there was not enough existing data to determine conditions and trends for all metrics across all grassland landscape units, ongoing mapping and monitoring efforts will inform future condition and trend analyses.

Metric 1 is dependent on finalizing a region-wide fine-scale grassland map and conducting consistent monitoring in selected plant communities. Metrics 2 and 3 conditions were preliminarily assessed based on the most recent draft of lifeform mapping by Tukman Geospatial (2023) which covers Alameda and Contra Costa Counties. The NatureCheck vegetation layer (EHA 2023) is utilized for San Joaquin and Santa Clara Counties, which is partially based on Conservation Lands Network (CLN; 2011) vegetation data. Metrics 2 and 3 had historical data covering a portion of the AOF to describe change between 1850 (Stanford et al. 2011) and recent times.

The general lack of existing data for all landscape units resulted in an overall condition and trend of "Unknown," with "Low" confidence. Both Metrics 1 and 2 had the same results as the overall assessment; however, the overall condition for Metric 3 was "Good" while trend was "Unknown" and confidence was "Low." At the landscape unit level, East Bay Hills was rated as "Significant Concern" for Metric 3 while the remaining landscape units were rated as "Good" based on patch size thresholds. The "Significant Concern" rating is likely due to the brush encroachment in the northern extent of the landscape unit.

This chapter summarizes the state of grassland-related science, identifies recommended monitoring and mapping efforts, and provides a framework to begin assessing condition and change in grassland metrics across lands managed by Network partners.

METRICS SUMMARY AT A GLANCE

The condition, trend, and confidence for each of the three grassland metrics are summarized in the table below. Additional details are provided in the Metrics in Detail section below. Future iterations of this chapter may present condition, trend, and confidence for each of the landscape units individually.

Table 1. Condition, Trend, and Confidence for Grassland Metrics

Metric 1: Native grass and forb species cover and/or richness – Maintain or improve native species cover and/or richness in selected grassland classes for each of the landscape units, as per membership rules in a classification system (e.g., Manual of California Vegetation).	
Condition	Unknown
Trend	Unknown
Confidence	Low
Metric 2: Spatial extent of grasslands – Maintain or increase current spatial extent of total grassland acreage.	
Condition	Unknown
Trend	Unknown
Confidence	Low
Metric 3: Patch size – Maintain or increase average grassland patch size within each landscape unit to be over 25 acres.	
Condition	Good (Mount Diablo Range and Mount Hamilton Range); Significant Concern (East Bay Hills)
Trend	Unknown
Confidence	Low

CONDITION, TREND, AND CONFIDENCE SUMMARY

The overall condition, trend, and confidence assessment of the grasslands in the AOF represented by the graphic below is based on the combined values of the individual metrics.



Condition: Unknown (color: gray)

Trend: Unknown (symbol: question mark)

Confidence: Low (line around circle: absent)

BACKGROUND

WHY IS THIS RESOURCE INCLUDED?

Grasslands are the most widespread vegetation type in the AOF. They are among California's most altered ecosystems, with non-native plants making up more than 90% of the cover in most grassland areas (Mooney and Zavaleta 2016). Even in their current altered state, grasslands are extremely important for wildlife and support a high diversity of native plant species.

Grasslands provide critical ecosystem services in the AOF, including attenuation of storm water with relatively slow infiltration rates, and improvement of water quality through filtering of pathogens, nutrients, and sediments (Mooney and Zavaleta 2016). They also provide a relatively high rate of carbon storage per unit area based on plant community composition, clay content, litter cover, and potentially management (Silver et al. 2010, Booker et al. 2013, Conant et al. 2001). Grasslands are more likely to remain carbon sinks than forested lands (Dass et al. 2018). Within grasslands, native perennial grasslands sequester greater levels of carbon over annual grasslands, and both types of grasslands sequester greater levels of carbon than developed croplands (Koteen et al. 2011, Conant et al. 2001). Grasslands also support a wide diversity of pollinators (Colteaux et al. 2013).

DESCRIPTION OF GRASSLANDS IN THE AOF

This worksheet assesses grassland health within the AOF (**Figure 1**). The majority of the grasslands in the AOF are dominated by non-native naturalized annual grass and forb species with areas that feature relatively higher native plant species diversity and abundance. Although there has not been a consistent classification and mapping effort of grassland types throughout the AOF to date, most of the AOF grasslands would likely be classified as annual grasslands according to the California Wildlife Habitat Relationships system (Mayer and Laudenslayer 1988), broadly synonymous with interior grasslands (Mooney and Zavaleta 2016), valley grasslands (Bartolome et al. 2007), and wild oats and annual brome grasslands (*Avena* spp. - *Bromus* spp. Herbaceous Semi-Natural Alliance, Sawyer et al. 2009).

The classification of grasslands into a given system depends on membership rules that typically include a cover threshold of one or more dominant or indicator species (Sawyer et al. 2009). Indicator plant species may be used to identify, characterize, and more easily refer to these diverse grassland plant communities. The occurrence, abundance, or vigor of a given indicator species often suggests particular site conditions that support related plant communities (Gabriel and Talbot 1984, Sawyer et al. 2009).

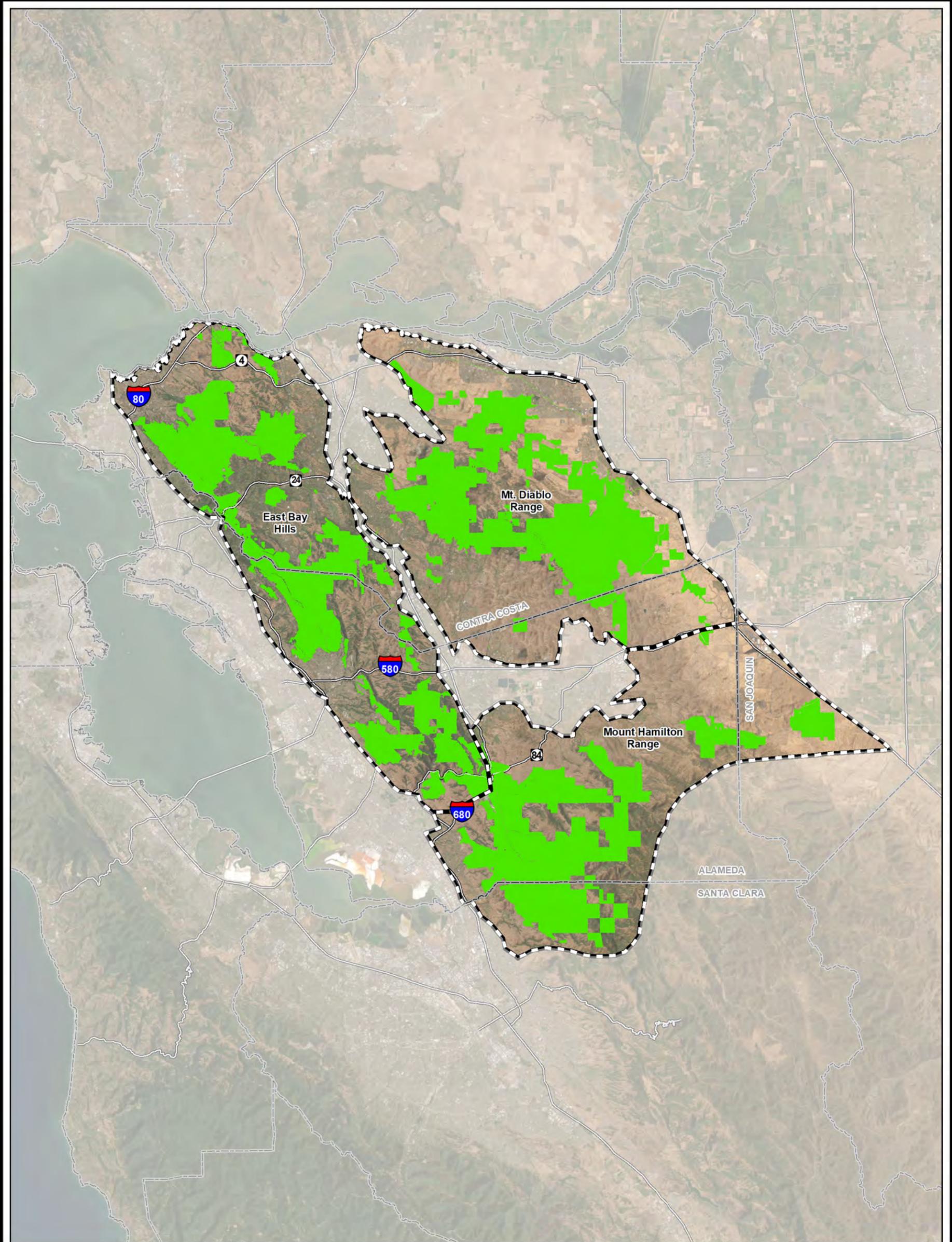
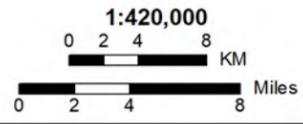


FIGURE 1.
Area of Focus and Partner Lands
 Contra Costa and Alameda Counties,
 California

Legend

-  Highway
-  Partner Land
-  Area of Focus
-  County Boundary



Data Sources: EBRPD/EHA, 2020 | VNLC, 2023
 TIGER, 2000 | Gap, 1998
 GIS/Cartography by R. Foss, 2023
 Document Name: 575_Fig1_EHA_B-P_2023-1226

Characteristic non-native species found in the grasslands of the AOF include wild oats (*Avena* spp.), bromes (*Bromus* spp.), and filaree (*Erodium* spp.). The patchy distribution of remnant stands of native sub-dominant species, such as needlegrasses (*Stipa* spp.), wild ryes (*Elymus* spp.), and various forbs, may also be used as indicators of more widespread distribution before Euro-American influences (Cunningham 2010). Variation in the grassland species composition and distribution are highly influenced by environmental conditions, including soils, geology, topography, fog, and inter- and intra-annual precipitation patterns, which vary greatly across the AOF (Bartolome et al. 2007).

The grasslands of the AOF are highly variable since they span a large geographic area with large variations in climatic and edaphic factors. For example, the grasslands in the higher elevation western extent of the AOF, such as EBRPD Wildcat Canyon Regional Park and Sobrante Ridge Regional Preserve, experience more precipitation and fog than grasslands to the east, such as EBRPD Black Diamond Mines Regional Preserve and Carnegie State Vehicular Recreation Area. Moisture influences plant species composition, dynamics, and response to management. Grasslands in the western portion of the AOF may include more coastal herbaceous species (e.g., California oatgrass [*Danthonia californica*] and California brome [*Bromus carinatus*]), while grasslands in the east have higher frequencies of interior species (e.g., one-sided blue grass [*Poa secunda*], salt grass [*Distichlis spicata*], and alkali barley [*Hordeum depressum*]).

Unique subtype native grassland and forbland patches are also found within the matrix of dominant annual grasslands, with patch distribution similarly based on the factors described for the dominant and sub-dominant grasslands. Two key unique subtype grasslands, vernal pool and serpentine grasslands, have received significant scientific attention, contributing to a better understanding of their distribution, composition, and interaction with management (e.g., Marty 2005, Weiss 1999). Additional subtype grasslands, including clay barrens, alkali grasslands, and remnant or “old growth” grasslands with greater cover and diversity of native grasses and/or forbs, occur throughout the AOF but are not as well studied or mapped (Holstein 2001, Veldman et al. 2015).

Environmental factors interact with historic and current land management, fire regimes, herbivory, pollinators, pathogens, inter-specific competition, and microbes to further influence grassland composition and distribution (Mooney and Zavaleta 2016, Gennet et al. 2017). All of the grasslands in the AOF are assumed to have had historic livestock grazing and the majority of the grasslands are currently managed with livestock, primarily cattle with some sheep. Mount Diablo State Park is a notable exception to that management regime. Although livestock grazing remains the main landscape-level vegetation management tool utilized by most Network partners, it is known to result in both positive and negative natural resource impacts at multiple temporal and spatial scales (Bartolome et al. 2014). For example, livestock effectively reduce biomass of targeted competitive naturalized annual grassland taxa, often increasing native forb abundance and diversity, but also increasing cover of invasive forbs and having variable effects on native grasses (Hayes and Holl 2003).

The AOF consists of three NatureCheck landscape units: East Bay Hills, Mount Diablo Range, and Mount Hamilton Range (**Figure 1**). **Appendix A** describes alternate grassland landscape units that better reflect grassland plant communities and extend beyond the AOF to include all EBRPD lands.

East Bay Hills – The East Bay Hills landscape unit is defined to the west by the distinct Hayward fault line, which coincides with the edge of major urban development. The unit receives the highest levels of precipitation within the AOF due to the orographic precipitation along its north-south trending ridgelines and proximity to the coast. The geology east of the Hayward fault line and associated faults is highly altered by faulting and folding of various formations, including Tertiary sedimentary rocks, Great Valley Sequence, ocean floor segments (Claremont Formation; serpentine), alluvial fan accumulations (Orinda formation), and lava flows (Moraga volcanics; Case 1968, Smith nd.). The higher precipitation levels and variable geology of the landscape unit contribute to a unique assemblage of sensitive plant species and communities amongst the landscape units. In particular, the unit supports areas with higher productivity and frequencies of coastal prairie indicator species and native plant communities, such as Idaho fescue - California oatgrass grassland (*Festuca idahoensis* - *Danthonia californica*) and California brome - blue wildrye prairie (*Bromus carinatus* - *Elymus glaucus*). Other more cosmopolitan or inland communities are also well represented; examples of mapped communities include needle grass - melic grass grassland (*Nassella* spp. - *Melica* spp.); California poppy - lupine fields (*Eschscholzia [californica]* - *Lupinus [nanus]*); sand-aster and perennial buckwheat fields (*Corethrogyne filaginifolia*-*Eriogonum [elongatum, nudum]*); and ashy ryegrass - creeping wildrye turfs (*Leymus cinereus* - *Leymus triticoides*). Briones and Wildcat Canyon Regional Parks, East Bay Municipal Water District (EBMUD) lands, and many other partner agency land holdings occur in this landscape unit.

Mount Diablo Range – This landscape unit is in the geographic center of the AOF and experiences intermediate precipitation levels and productivity when compared to landscape units to the west (East Bay Hills) and east (San Joaquin). Geology of the landscape unit is diverse and includes Franciscan Complex, Great Valley Sequence, Mount Diablo Jurassic Ophiolite, Tertiary volcanic tuff formations, and Quaternary and Tertiary sedimentary rocks. Thrust block faulting caused the uplift and folding evident in the vicinity of Mount Diablo (MDIA 2020), including the exposure of serpentinite within Mount Diablo State Park. The grasslands in the unit are predominantly valley grasslands with smaller patches of unique grassland types, such as clay barrens, serpentine grasslands, and remnant “old growth” grasslands. Documented native herbaceous plant communities in the unit include needle grass - melic grass grassland; sand-aster and perennial buckwheat fields; ashy ryegrass - creeping wildrye turfs; California poppy - lupine fields; and Idaho fescue - California oatgrass grassland as well as transitional wetland communities including yerba mansa - Nuttall's sunflower - Nevada goldenrod alkaline wet meadows (*Anemopsis californica* - *Helianthus nuttallii* - *Solidago spectabilis*). This landscape unit is centered around Mount Diablo State Park, and includes EBRPD Morgan Territory and Brushy Peak Regional Preserves, among other partner lands.

Mount Hamilton Range – The Mount Hamilton Range landscape unit is in the southwestern portion of the AOF. Like the Mount Diablo Range unit, this unit experiences moderate levels of rainfall and productivity. Geology of this area includes Quaternary alluvium terrace at the lowest elevations, moving into Quaternary to Tertiary sedimentary rocks, before the major block of underlying Great Valley Sequence and Franciscan Complex are exposed in the southern and eastern portions of the unit. Unique geology of the unit includes Jurassic serpentinite scattered throughout and limestone formations along the western ridge near San Antonio Reservoir (Jennings et al. 1977, Sloan 2006). The grasslands of the Mount Hamilton Range unit primarily consist of valley grasslands with smaller patches of unique grassland types, such as serpentine grasslands and remnant “old growth” grass and forblands. Example plant communities include needle grass - melic grass grassland, California brome - blue wildrye prairie, sand-aster and perennial buckwheat fields, Idaho fescue - California oatgrass grassland, and ashy ryegrass - creeping wildrye turfs alliances. More unique herbaceous communities include California goldfields - dwarf plantain - small fescue flower fields (*Lasthenia californica* - *Plantago erecta* - *Vulpia microstachys*), coastal tufted hair grass - meadow barley - California oatgrass meadow (*Deschampsia cespitosa* - *Hordeum brachyantherum* - *Danthonia californica*), fiddleneck - phacelia fields (*Amsinckia* [*menziesii*, *tessellata*] – *Phacelia* spp.), and goldenaster patches (*Heterotheca* [*oregona*, *sessiliflora*]). This landscape unit includes the San Francisco Public Utilities Commission (SFPUC) Alameda Creek watershed and EBRPD Sunol, Ohlone, and Lake Del Valle Regional Parks.

DESIRED CONDITION AND TREND

Resilient grasslands are better able to persist in more extreme environmental conditions, such as prolonged drought and increased temperature ranges (Hoover et al. 2014, Voltaire et al. 2014). Diversity of plant species within a community, genetic variation within taxa, and plasticity of physiological traits of constituent plants contribute to a resilient grassland (Harrison et al. 2015, Vicente-Serrano et al. 2013, and Craine et al. 2013). Resilient grasslands provide habitat for native species, supply quality forage to livestock, support water recharge, protect landscapes from erosion, and participate in the nitrogen and carbon cycles. The desired condition is to maintain, support, or create resilient grasslands within a broader ecosystem in the face of climate change and anthropogenic impacts. The resilience of the grasslands in the AOF may be assessed by native grass and forb species cover and/or richness, current spatial extent (acreage) of grasslands, and patch size.

CURRENT CONDITION AND TREND

Condition: Unknown.

Trend: Unknown.

Confidence: Low.

Inadequate data exist to assess the overall condition and trend of grasslands in the AOF according to the selected metrics. Some initial assessments have been made for portions of the AOF where adequate data is available, as described for each metric. A comprehensive mapping and classification of historical and current vegetation types throughout the AOF will dramatically improve the accuracy of the condition assessment by creating spatially-explicit grassland areas to assess and monitor for native species diversity and abundance, total acreage, and patch size.

STRESSORS

- 1) **Climate change:** Environmental changes brought by climate change may include increased CO₂ levels, increased nitrogen deposition, increased temperature, and changes in timing and distribution of precipitation. These changes in isolation or combination may alter grassland species composition and productivity, generally facilitating increased dominance of non-native annual grass species. Grassland community changes were found to be dependent on the type of environmental changes, but a general decrease in forb diversity was apparent for most scenarios (Zavaleta et al. 2003). Elevated CO₂ may reduce plant productivity, increase lignin in grasses, and increase forb biomass (Henry et al. 2005, Henry et al. 2006). Increases in available nitrogen, largely from regional anthropogenic sources, may increase the competitive edge of non-native annual grass species within previously edaphically-limiting grasslands, such as those on serpentine soils (Weiss 2001, Vallano et al. 2012). In an annual grassland community, litter decomposition increased (Henry et al. 2006), and overall diversity, especially of forbs, decreased with increased nitrogen (Zavaleta et al. 2003, Harpole et al. 2007).
- 2) **Invasive species:** Non-native plant species have dramatically altered grasslands in the AOF and throughout the state, causing a complete shift in species composition and associated ecosystem processes. Two major suites of non-native grassland species have invaded the grasslands within the AOF: 1) an initial invasion of now naturalized species (e.g., oats and bromes) that occurred during early Euro-American livestock grazing, and 2) a novel set of invasive species that are increasing in extent (e.g., medusa head [*Elymus caput-medusae*] and false brome [*Brachypodium distachyon*]; Bartolome et al. 2007). Invasive species outcompete native species for resources and reduce native plant persistence and cover. Invasive species may alter ecosystem processes (e.g., fire frequency, carbon storage), and may create conditions that favor their own reproduction and dominance (e.g., thatch persistence, allelopathic chemicals; Koteen et al. 2011). These species also have the potential to negatively impact native pollinators and other associated wildlife species (Bossard and Randall 2007). Wild pigs are the primary non-native wildlife species of concern for AOF grasslands as they consume native geophytes and increase ground disturbance from rooting, which further alters the plant community and facilitates exotic plant species (Cushman et al. 2004).

- 3) Shrub encroachment:** Shrub encroachment is a key stressor within the broader Habitat Loss and Change category that also relates to the Fire and Grazing Regime Change category, as defined for the assessment as a whole. The western extent of the AOF features a dynamic mosaic of grassland and northern coastal scrub, consisting primarily of coyote brush (*Baccharis pilularis* ssp. *consanguinea*) scrub (Keeley 2005). Since the grasslands closer to the coast have higher moisture from fog and precipitation, shrub encroachment is more prevalent there. Coyote brush scrub has the potential to dominate in coastally influenced grasslands in the absence of disturbance (Hobbs and Mooney 1986). Studies of historical vegetation change in the East Bay Hills has shown a dramatic shift from grassland to coyote brush due to lack of fire and grazing (McBride and Heady 1968, McBride 1974, Keeley 2005).
- 4) Habitat fragmentation and edge effects:** One aspect of concern within the assessment-wide Habitat Loss and Change category is the fragmentation of habitat and increase in edge effects. Smaller, more irregularly shaped habitat patches have an increased perimeter to area (P/A) ratio than larger, more circular habitat patches. The increased P/A ratio causes the interior portions of the patch to be relatively closer to the edges. The proximity to habitat edges causes an increase in often negative impacts, termed edge effects (Jørgensen and Fath 2008). Habitat fragmentation may reduce the success of grassland-dependent plant and wildlife species and populations by increasing predation and invasion, and reducing dispersal and gene flow. Specific effects from habitat fragmentation and increased P/A ratio vary by existing species composition, adjacent habitat types, and characteristics of the impacted species (Robinson et al. 1995, Quinn and Robinson 1987, Collinge and Palmer 2002). While the AOF is limited to protected lands, grasslands throughout the region and state have historically and continue to become reduced in overall acreage and patch size, increasing edge effects.
- 5) Grazing management:** Within the Fire and Grazing Regime Change category, particular aspects of grazing management are problematic for grasslands. All of the grasslands in the AOF are assumed to have historical livestock grazing; most support ongoing seasonal or year-round domestic livestock grazing; and all continue to receive some level of herbivory from native wildlife, including ungulates, small mammals, and invertebrates. Livestock use has been noted as a potential threat to various sensitive plant and wildlife species over time (CNDDDB 2020). Concerns include direct loss of individuals from trampling or incidental consumption, as well as indirect effects from alteration of plant communities and ecosystem function (Painter 1995). Livestock grazing management is complex and requires balancing often oppositional goals. For example, livestock grazing has been shown to increase native forb richness and native grass cover while increasing invasive forb cover (Stahlheber and D'Antonio 2013).
- 6) Altered fire regimes:** The stressors associated with altered fire regimes are considered here in isolation, although they would be lumped within the Fire and Grazing Regime Change in the overarching assessment. The existence and distribution of AOF grasslands are associated with ongoing and historic disturbance regimes, including fire. The fire regime includes location of burns, fuel types and levels, fire frequency, seasonality, and intensity (Keeley et al. 2011).

Current fire suppression and exclusion practices in the region and state differ from the more frequent historic anthropogenic burns utilized by Native Americans and Euro-American livestock operators to maintain and expand grasslands (Rutherford et al. 2020, Stephens et al. 2007), but may be more consistent with pre-human contact burn levels (Keeley 2002). Recent large-scale and high intensity burns in the Bay Area, including parts of the AOF, may indicate yet another shift in fire regimes to come (Westerling and Bryant 2008). These fire regimes impact the distribution of plant communities, as discussed with scrub encroachment, as well as grassland plant community composition, particularly related to disturbance-dependent native and invasive species (Keeley 2001).

- 7) **Facility management, maintenance, and development:** Necessary actions for the management, maintenance, and development of facilities within the AOF fall within the broader Human Activity stressor category. The lands within the AOF are managed for a diverse set of goals and land uses, primarily recreation and water storage and conveyance, that may reduce grassland health or extent. Recreational and water systems facility management, maintenance, and development directly impact AOF grasslands. Facilities associated with these primary land uses generally require construction, expansion, and/or ongoing maintenance. On managed watershed lands, initial grassland acreage was lost to reservoir and water conveyance infrastructure construction, and may continue with expansion. AOF lands that are managed for recreation have reduced grassland extent in discrete areas for facility development (e.g., parking lots, visitor centers). Ongoing facility management may include use of pesticides, mowing, and ground clearing, which may impact adjacent grasslands. Utilities, such as gas or power lines, with easements on AOF lands also require maintenance and replacement, causing ground disturbance and altering plant communities.
- 8) **Recreation:** Another aspect of the Human Activity stressor category is the effects of passive recreation, separate from the facilities component. Many of the AOF grasslands support passive recreational use, including hiking, birdwatching, mountain biking, and horseback riding. Potential impacts from passive recreational use include increased erosion and associated sedimentation along roads and trails, as well as increased introduction of non-native invasive plant and pathogen species. Although designated trails may be maintained regularly to reduce erosion and off-trail sedimentation, unofficial social trails may not be designed properly or maintained to convey water, leading to erosion, gullying, and off-trail sediment deposition (Marion and Olive 2006). Trail and road networks within grasslands serve as vectors for potentially harmful plant and pathogen taxa that may become established if not identified and targeted soon after establishment (Potito and Beatty 2005, Ballantyne and Pickering 2015).

CONDITION AND TRENDS ASSESSMENT

METRICS IN DETAIL

Three metrics were identified to assess condition and trends of grassland health across the AOF. Metrics were selected to align with existing or anticipated datasets that would adequately inform the assessment. The three metrics include:

Metric 1: Native grass and forb species cover and/or richness – membership of selected grassland types within a classification system

Metric 2: Spatial extent of grasslands – total acreage of grasslands within grassland landscape units

Metric 3: Patch size – average patch sizes greater than 25 acres within grassland landscape units

Each metric is analyzed within the grassland landscape units in order to identify condition and trends for similar plant communities subject to regional stressors and management practices. The cover and diversity of native grass and forb species reflects the value that the Network partners assign to native grassland plant communities within the dominant non-native annual grasslands. The spatial extent metric addresses concern about total cover of grasslands within the AOF, while patch size addresses the minimum size of individual patches of grasslands. Ongoing efforts to classify and map grasslands at a fine-scale will improve the assessment of the selected metrics and may support selection of additional metrics considered but originally rejected for this worksheet iteration.

The selected metrics have or are anticipated to have adequate available data to preliminarily assess the baseline condition of grasslands in the AOF. Additional metrics, such as those discussed but dismissed, should be considered in the future to further assess and monitor grassland condition within a consistent long-term monitoring program throughout the AOF.

Metric 1: Native Grass and Forb Species Cover and/or Richness

Rationale: Resilient grasslands include the presence of native grass and/or forb species (Craine et al. 2013, Hoover et al. 2014). Historic grassland plant communities supported a higher diversity and cover of native plant species than are currently observed (Cunningham 2010). Carbon sequestration rates are greater in native perennial grass stands (Koteen et al. 2011).

Current Baseline: Unknown.

Native grass and forb species cover and/or richness may be monitored when more fine-scale grassland mapping and classification is available in the AOF. Once grasslands have been mapped according to a classification system, such as the Manual of California Vegetation (MCV), Network partners may select a subset of grassland classes that warrant long-term monitoring. Specific classes may be selected within each landscape unit based on their global or within AOF rarity, representativeness of a given landscape unit, or other management concern. All of the classes should have membership rules defined in the classification system that determine whether a monitored plant community continues to meet established cover or diversity threshold values. For example, the MCV classifies a surveyed grassland plant community as Idaho fescue - California oatgrass grassland (*Festuca idahoensis* - *Danthonia californica* Herbaceous Alliance) if the California oatgrass component has greater than 50% relative cover. This community may then be further classified to the association level (e.g., *Danthonia californica* - *Nassella pulchra*, *Heterotheca sessiliflora* - *Danthonia californica*). The California Native Plant Society (CNPS)/California Department of Fish and Wildlife (CDFW) approach includes a cutoff of 10% relative cover of native plant taxa for diverse plant communities, per membership rules. Patches (i.e., mapped polygons) of the selected classes could then be monitored annually at established plot locations, or “Sentinel Sites,” to observe any change in membership status within the corresponding mapped grassland.

Examples of potential grassland classes, based on MCV alliances, that may be selected for monitoring are listed below for each of the landscape units (Sawyer et al. 2009). Note that additional alliances may be generated during a systematic classification effort of the AOF that would more accurately depict the variety of grassland types observed, particularly grasslands with low native cover but relatively high diversity of native plant species (Bartolome et al. 2013, Nomad 2015).

- *East Bay Hills:* coastal prairie remnants (Idaho fescue - California oatgrass grassland; California brome - blue wildrye prairie), bunchgrass stands (needle grass - melic grass grassland), and serpentine (California goldfields - dwarf plantain - small fescue flower fields)
- *Mount Diablo Range:* clay barrens within annual grasslands (not well classified), bunchgrass stands (needle grass - melic grass grassland), and serpentine (purple three-awn - squirreltail - curly blue grass patches)
- *Mount Hamilton Range:* forb fields (fiddleneck - phacelia fields, popcorn flower fields), and serpentine (California goldfields - dwarf plantain - small fescue flower fields)

Condition Goal:

- Maintain or improve native species cover and/or richness in selected grassland classes for each of the landscape units, as per membership rules in a classification system (e.g., MCV).

Condition Thresholds:

- *Good*: All grasslands selected for monitoring continue to meet established native plant membership rules in five or more years over a 10-year monitoring period.
- *Caution*: Any of the grasslands selected for monitoring only meet established native plant membership rules in two to four years over a 10-year period.
- *Significant Concern*: Any of the grasslands selected for monitoring do not meet established native plant membership rules in one or fewer years monitored over a 10-year period.

Condition: Unknown. Sentinel sites have not been selected or monitored.

Trend: Unknown. Trends may be assessed once multiple years of data have been taken.

Data available within the AOF has not generally been utilized for a trend analysis of native species cover and richness, largely due to the stochasticity of the annual native species within the context of highly variable intra-and inter-annual climatic variation (Bartolome et al. 2011). Historical literature indicates that there has been a dramatic decline in native grassland species cover and diversity since European occupation (Cunningham 2010). Anecdotal evidence from agency and advocacy groups indicate that more recent declines may be continuing, but this has not been well documented outside of specifically monitored populations of listed species (CNDDDB 2020).

Confidence: Low.

Although individual agency and research-based plant community monitoring data is available in portions of the AOF, a representative and shared baseline plant community dataset is not available. A formal assessment of the baseline condition of native grass and forb species richness in grasslands is dependent on a consistent classification and mapping effort of current and historic vegetation types undertaken throughout the AOF that incorporates plot-based plant community monitoring.

Metric 2: Spatial Extent of Grasslands

Rationale: Maintenance of existing grassland acreage is important for supporting grassland-dependent wildlife and plant species, as well as viable livestock operations that may be used as a management tool. Maintenance of existing grassland acreage indicates that the AOF continues to provide grassland-associated ecosystem services.

Current Baseline: The five partner agencies manage over 107,000 acres of grasslands in the AOF. The distribution of grassland acres within the landscape units is presented in **Table 2**, below.

The grassland acres were calculated by using a combined dataset based primarily on the draft lifeform map provided by Tukman Geospatial (2023) for Alameda and Contra Costa Counties as well as the original vegetation data used by the Ecological Health Assessment (EHA; 2023) for San Joaquin and Santa Clara Counties. Ongoing efforts to classify and map vegetation across Alameda and Contra Costa Counties will provide a more accurate set of acreages. Existing historical vegetation data from approximately 1850 (Stanford et al. 2011) covers a portion of the Mount Diablo Range landscape unit. However, this dataset is not complete for the entire AOF. Furthermore, 1850 may or may not be an appropriate baseline as it acts a snapshot of vegetation management practices at a given time. If the historical dataset is expanded, it may be considered for use as a baseline, considering its limitations.

Table 2. Spatial Extent of Grasslands in Partner Lands by NatureCheck Landscape Unit

NatureCheck Landscape Unit	Total Grassland Acres in AOF
East Bay Hills	23,903
Mount Diablo Range	49,444
Mount Hamilton Range	34,397
Total	107,743

¹ Tukman Geospatial 2023 and EHA 2023

Condition Goal:

- Maintain or increase current spatial extent of total grassland acreage.

Condition Thresholds:

- *Good:* Current total acreage of existing grasslands is maintained within 1%, or increase spatial extent within a given landscape unit.
- *Caution:* Decrease in total acreage of existing grasslands by 1-3% within a given landscape unit.
- *Significant Concern:* Decrease in total acreage of existing grasslands by more than 3% within a given landscape unit.

Thresholds used here are based on partner agency discussion and analysis of available recent and historic vegetation mapping datasets that only cover a portion of the landscape units. Future worksheet iterations may improve the thresholds to better reflect all landscape units.

Condition: Unknown. Only a small portion of the three landscape units had reliable historical grassland extent data. Condition may be determined if this historical dataset is expanded and/or future mapping efforts are compared to current condition as a baseline.

Trend: Unknown. Additional historical data is needed to establish a trend for all landscape units. Conversely, the current baseline may be used for future comparisons.

A preliminary comparison of the more accurate mapping of historical (1850; Stanford et al. 2011) and recent (ECCCHC 2014) vegetation types was available within portions of the AOF in the Mount Diablo Range landscape unit. In portions of the Mount Diablo Range unit, the majority of historical grasslands remained grasslands (see **Table 3**). The conversion of 1,076 grassland acres to the Los Vaqueros Reservoir represented the largest conversion observed. Minor amounts of ruderal, chaparral, oak woodland and savanna were gained and lost; this may be more indicative of slight variations in mapping thresholds than true change in vegetation types. Conversion to ruderal and urban around roadways and homesteads was also observed. Grassland was also lost to turf at Contra Loma Regional Park and to Roddy Ranch golf course (now in process of restoration).

Table 3. Change in Spatial Extent of Grasslands within Partner Lands in a Portion of the AOF

NatureCheck Landscape Unit	Grassland Acres ¹	Historical Grassland Acres ²	Net Percent Grassland Acreage Lost
Mount Diablo Range	31,296	32,762	4%

¹ ECCCHC 2014.

² Stanford et al. 2011.

Confidence: Low.

Available time series data that cover the entire AOF are temporally limited and inaccurate at a meaningful scale. Available datasets have known errors, including inconsistent or unknown original mapping techniques (Kelly et al. 2005), inaccurate polygon delineation (ibid), limited ground truthing (Tukman Geospatial 2023, CLN 2011, Stanford et al. 2011, Kelly et al. 2005), and variable definitions of key grassland types (Kelly et al. 2005, Tukman Geospatial 2023, CLN 2011, Stanford et al. 2011, ECCCHC 2014). An improved historical and current vegetation classification and mapping effort covering the entire AOF would vastly improve confidence in defining the baseline, trend, and thresholds for all landscape units.

Metric 3: Patch Size

Rationale: Larger grassland patches with greater inter-patch connectivity and higher intra-patch habitat heterogeneity are more likely to support viable populations and greater diversities of grassland-associated pollinators, native plant species, and sensitive wildlife species. The patch size thresholds of this worksheet are based on regional to global studies summarized in **Table 4** below. Studies focusing on grass-specific ecosystems were selected over wildlife-related patch sizes because wildlife metrics are discussed in other chapters. Future iterations of this metric may incorporate wildlife-related patch size into the thresholds.

Table 4. Grassland Patch Literature Summary

Ecosystem Service/ Function	Patch Size Minimum	Ideal Patch Distribution	Source	Study Location/ Scale
General	30 acres	N/A	Edson et al. 2016	Bay Area
Wind dispersal	N/A	Adjacent patches	Soons et al. 2005	Europe
Gene flow	N/A	Connected by non-forest landscape	Jacquemyn et al. 2010	Europe
Pollinators: general	“Bigger”	“closer”	U.S. Forest Service Best Management Practices	National
Insects	“Larger”	Connected with corridors; internally diverse	Steffan-Dewenter and Tschardt 2002	Europe
Pollinators: bees	N/A	Natural habitat within 1-2.5 km of target habitat	Kremen et al. 2004	Central Valley
Pollinator: butterfly	>10 ha (25 ac.)	Corridors; diverse habitat	Ehrlich and Murphy 1987	Bay Area
Pollinator: butterfly	6-10 ha (15-25 ac.)	N/A	Ockinger and Smith 2006	Europe
Plant species diversity	“larger” 0.9 ha avg in study sites (0.03-5.1 ha or 0.07-13 ac. range)	Isolation not significant factor	Krauss et al. 2004	Europe
Species diversity	A 100% increase in area produces roughly a 25% increase in species.	N/A	Gilpin and Diamond 1980	Global
Seed exchange	Larger (0.02-8.5 ha or 0.05-21 ac. range)	Genetic loss mitigated by livestock movement	Honnay et al. 2006	Europe

Large patches inherently have more habitat diversity and can accommodate larger and more genetically diverse populations of critical species. Larger patch sizes also reduce negative edge effects

(e.g., invasion and predation) for sensitive species. Patch connectivity improves potential gene flow of grassland plant species, which is dependent on dispersal and exchange of pollen and seeds within and between populations. Greater genetic diversity within and gene flow between populations improves the potential for species to adapt to changing conditions.

Multiple studies identified a distinct benefit conferred to pertinent ecosystem services at 20 to 30 acres. Twenty-five acres was selected in order to identify an appropriate threshold that would indicate grassland health. Although 25 acres was selected as the minimum recommended patch size, many studies also stated that larger in general is better. However, since there were no additional thresholds above the 20-to-30-acre range, it was not appropriate to assign a second larger tier for assessment at this time.

Current Baseline: The existing vegetation data provided by CLN (2011) may serve as an interim baseline until more accurate mapping is completed. The historical vegetation map (Standford et al. 2011) is not currently used as a baseline but may be considered if the map extent expands.

Condition Goal:

- Maintain or increase average grassland patch size within each landscape unit to be over 25 acres.

Condition Thresholds:

- *Good:* Average grassland patch size is at least 25 acres within each landscape unit.
- *Caution:* Average patch size is between 15 to 25 acres within each landscape unit.
- *Significant Concern:* Average patch size is less than 15 acres within each landscape unit.

Condition:

- *Good:* Mount Diablo Range, Mount Hamilton Range
- *Caution:* None
- *Significant Concern:* East Bay Hills

The overall condition may be categorized as “Good” because the average patch size across all landscape units is 30 acres, which is above the 25-acre threshold. However, condition varies by landscape unit: only Mount Diablo Range and Mount Hamilton Range had average patches greater than 25 acres while East Bay Hills had an average patch size less than 15 acres (**Table 5**). Patches include all contiguous grassland area as mapped by Tukman Geospatial (2023) in Alameda and Contra Costa Counties and EHA (2023) in San Joaquin and Santa Clara Counties. CLN patches are divided by major roads (more than two lanes) but not by smaller arterial roads. Patches may include islands of other vegetation (e.g., oak woodlands within drainages) as long as the grassland vegetation is contiguous in another location.

Table 5. Grassland Patch Size in Partner Lands by NatureCheck Landscape Unit

NatureCheck Landscape Unit	Average Patch Size (acres) ¹	Condition
East Bay Hills	14	Significant Concern
Mount Diablo Range	49	Good
Mount Hamilton Range	35	Good

¹ Tukman Geospatial 2023 and EHA 2023; Note: Grassland patches that occur in two or more landscape units are counted in each landscape unit in order to avoid creating and counting falsely small patches.

The East Bay Hills landscape unit has an average patch size well below the minimum patch size (25 acres). This is in part due to the relative isolation of this landscape unit from other units due to surrounding urban development. The Mount Diablo Range and Mount Hamilton Range landscape units include larger undeveloped areas with larger intact grassland patches.

The East Bay Hills landscape unit is also subject to brush encroachment due to higher precipitation levels. Expanding the historical vegetation mapping effort into this landscape unit would provide important context for the dynamics in grassland patch size due to reduced disturbance levels (McBride and Heady 1968, McBride 1974, Keeley 2005). These trends are particularly notable in the northern extent of the East Bay Hills landscape unit, which has higher relative precipitation levels and include lands with notable lack of recent disturbance (e.g., EBRPD Tilden Regional Park). The significant concern condition indicates that these grasslands will require management to slow or reverse further patch size reduction. Efforts are underway within EBRPD-managed lands to manage brush encroachment.

The ongoing vegetation mapping effort underway will further improve an assessment of patch sizes within each landscape unit.

Trend: Unknown. Additional historical data is needed to establish a trend. Conversely, the current baseline may be used for future comparisons.

An initial trend assessment comparing the most accurate historical (1850; Stanford et al. 2011) and recent (ECCCHC 2014) vegetation type mapping available in portions of the AOF indicates that average patch size has remained well above 25 acres between 1850 and modern times (**Table 6**). The major decrease between historic and recent patch size is likely due to the increase in roads dividing the major grassland patch along the eastern range.

Table 6. Change in Grassland Patch Size in Partner Lands Over Time in a Portion of the AOF

NatureCheck Landscape Unit	Average Patch Size (acres) ¹	Average Historical Patch Size (acres) ²
Mount Diablo Range	109	425

¹ ECCCHC 2014.

² Stanford et al. 2011.

Confidence: Low.

The most accurate mapping of historical and modern vegetation is limited to portions of the Mount Diablo Range landscape unit. Only relatively coarse modern (Tukman Geospatial 2023, EHA 2023, and CLN 2011) and historical (Kelly et al. 2005) vegetation classification and mapping data was available for the entire AOF. An improved classification and mapping effort of the entire AOF would vastly improve estimations of baseline, threshold, and trends in grassland patches within all landscape units.

OTHER METRICS CONSIDERED BUT NOT INCLUDED HERE

- **General note:** Future worksheet versions may assess different metrics for each of the landscape units. These metrics may be tailored to address and monitor specific concerns facing individual landscape units. This approach would ensure that each metric is most applicable, best studied, or otherwise most appropriate for each landscape unit. Results from the ongoing fine-scale grassland mapping effort may justify separating out metrics of interest.
- **Structural diversity in grasslands** – This was removed since it was primarily a metric for wildlife use. Structural diversity was removed from the grassland metrics because there are other indicators evaluating stressors to wildlife that use grasslands.
- **Interior grassland subtypes: native cover and richness** – This metric was combined with the current Metric 1 that assesses native grass and forb species richness and/or cover in order to encapsulate a greater potential range of monitored grasslands types. The monitored grassland types have yet to be selected for each landscape unit and may include serpentine and alkali grassland types in the units where they occur. Vernal pools and alkali wetlands are both uniquely characterized by the presence of native and endemic plant species (as well as their unique hydrology and soil types), but are distinctly wetlands although within a larger grassland matrix.
- **Patch distribution** – Research on grassland patch distribution in the state and globally indicated that immediate patch connectivity was important for maintaining grassland-associated species and populations. Little pertinent literature was found that recommended specific distances between grassland patches beyond identifying that connected, more frequent, and adjacent habitat patches improved success of grassland-associated species (Ehrlich and Murphy 1987, Soons et al. 2005, Jacquemyn et al. 2010). Connected or adjacent grassland patches are considered one unit or patch in this worksheet. Within-patch diversity, addressed below, describes a potential metric examining the importance of adjacent diverse patches.
- **Within-patch diversity** – A future iteration of this worksheet may incorporate a metric similar to the following: “Maintain or increase diversity of adjacent/connected grassland patch types.” Multiple studies of grassland pollinators and seed dispersal mechanisms indicate that fine-scale heterogeneity within larger grasslands improves local population outcomes (Ehrlich and Murphy 1987, Soons et al. 2005, Steffan-Dewenter and Tschamtkke 2002). This type of metric would only be possible after a relatively fine-scale classification and mapping effort is

completed for the AOF where adjacent grassland types may be considered as a heterogeneous unit.

- **Thatch and bare ground** – Some sensitive plant communities, such as vernal pools and serpentine grasslands, have been shown to respond positively to lower thatch and higher bare ground levels, often maintained through grazing management (Marty 2005, Weiss 2001). However, there is a lack of studies quantifying recommended thatch, biomass, and bare ground levels in relation to diversity and abundance of most native plant species that are generally found intermixed within the dominant grassland type. While a specific metric for thatch and bare ground was not selected for this iteration of the indicator worksheet, inclusion of biomass and bare ground monitoring as part of monitoring grassland diversity should improve the understanding of potential bare ground and thatch impacts on grassland communities of interest.
- **Invasive Species** – Although new problematic invasive grass species (e.g., false brome, medusa head) are a serious threat to regional grassland plant communities, dominant and subtype grassland community health is adequately addressed by Metric 1, which directly measures native plant diversity and abundance. Measurement of invasive species cover, individually or as a guild, as part of monitoring would help inform individual or regional management decisions.

DATA, MANAGEMENT, AND SUPPORTING INFORMATION

DATA GAPS AND DATA COLLECTION/MANAGEMENT NEEDS

Metric 1: Native grass and forb species cover and/or richness

- Grasslands in the Bay Area have several datasets that are relatively consistent in how species composition is measured, but the locations of the monitoring plots are not representative of all grassland plant community types and are not well distributed throughout the AOF. There are some site-specific species composition monitoring data (EBRPD, SFPUC, State Parks), but the distribution of monitored plots reflects other research or management goals and does not accurately represent the variety of grassland classes of interest for this metric.
- A thorough classification and mapping effort of target current and historical vegetation types throughout the AOF would inform more methodical monitoring of all metrics in this worksheet. If the mapping effort is based on the MCV or another suitable classification system, a representative subset of the mapped grassland areas could then be monitored to assess baseline and change in native grass and forb species richness in relation to explicit membership rules in the classification system. In the case that a comprehensive classification and mapping effort throughout all vegetation types of the AOF is not feasible, the following alternatives may be more attainable in the near term: 1) map current (and historic, if possible) vegetation within a representative subset of partner lands within each landscape unit; 2) focus on mapping and classifying existing grasslands rather than all vegetation types; 3) map and classify selected properties in the AOF that anecdotally harbor the greatest diversity of potential grassland classes; and/or 4) map broad historical vegetation classes in representative AOF properties in Contra Costa County, where historical photography is readily available.
- Once a full-scale or modified mapping and classification effort has been implemented in the AOF, a set of grassland classes should be selected for long-term plant community monitoring to better inform Metric 1. The grassland classes selected for ongoing monitoring should include dominant, unique, and/or sensitive grassland plant communities that are characteristic of each landscape unit. Long-term plot-based plant community monitoring could then occur at multiple locations per selected class, ideally representing a range of geographic, edaphic, and land use histories, where available. The number of classes and replicates within each class selected for regular monitoring may vary by agency availability and funding.
- Alkali grasslands and sinks were not included in this assessment. Alkali sinks were considered wetlands and may be considered with a different indicator for the East Bay Ecological Health Assessment. Upland alkali grasslands are often transitional areas between alkali wetlands and dominant interior grasslands, featuring more common native grassland species (e.g., salt grass) but generally lacking the more unique suite of sensitive native plant species found in the wetter areas. Analysis of California Natural Diversity Data Base (CNDDDB) data in the region confirmed

that sensitive plant species, such as various listed *Atriplex* species, were almost exclusively associated with wet alkali features rather than the upland alkali grasslands (CNDDDB 2020). Also, it is anticipated that a relatively robust vegetation mapping effort throughout the AOF would likely capture notable alkali grassland stands.

- Unique plant communities associated with clay barrens, which are generally found on Altamont-Fontana and Altamont clay soil types, have not been well studied. While anecdotal evidence and white literature have indicated associations with a few listed plant species such as shining navarretia (*Navarretia nigelliformis* ssp. *radians*), clay barrens may also support unique assemblages of more common native plant species (Nomad 2015). Future iterations of this worksheet may incorporate clay barrens as a monitored subtype when more widely available data to support its inclusion are available.

Metric 2: Spatial extent of grasslands

- The region-wide modern vegetation mapping effort undertaken by CLN lacks significant ground-truthing and is largely based on coarse state-level landscape classification work (CLN 2011). The East Contra Costa County Habitat Conservation Plan (ECCCHCP) process included improved mapping of recent vegetation types within a portion of the Mount Diablo Range landscape unit (ECCCHC 2014). Tukman Geospatial (2023) also improved the accuracy of the remotely sensed vegetation type data with more recent imagery. All acreage calculations and analyses carry the inaccuracies of the source datasets.
- Existing historical vegetation mapping datasets are problematic for use in trend analysis and establishment of meaningful thresholds for this worksheet. Region-wide historical vegetation mapping (Kelly et al. 2005) was assessed for relative accuracy in comparison to Contra Costa 1939 aerial photography (Google Earth 1939). Many errors in the historic vegetation map were detected that would influence acreage calculations of vegetation types and subsequent analyses of changes between historical and modern plant communities. However, a more careful and fine-scaled mapping effort was undertaken for the ECCCHCP to estimate plant community extents in 1850 (Stanford et al. 2011).
- Historical vegetation type mapping that characterizes basic vegetation classes (e.g., grassland, oak woodland, chaparral) would provide context for grassland acreage and patch gains and losses. Mapping current and historic non-grassland vegetation types would improve understanding of how AOF grasslands have changed over time and the relationships between other land cover types of interest. For example, mapping all vegetation types would allow ecologists to estimate the number of grassland acres transitioning between coyote brush scrub, oak woodland, and wetlands.

Metric 3: Patch size

- Few studies regarding key grassland patch size and distribution exist within the AOF. Various studies from outside the region or state reflect potential patch-related recommendations to support general grassland-associated ecological services.
- Grassland-associated wildlife patch sizes were not included in this version of the assessment. Future iterations may incorporate findings from studies relating to preferred or necessary grassland patch sizes for key wildlife taxa or guilds, such as grassland birds, granivores, California tiger salamander (*Ambystoma californiense*), California red-legged frog (*Rana draytonii*), San Joaquin kit fox (*Vulpes macrotis*) and/or California ground squirrels (*Otospermophilus beecheyi*).

PAST AND CURRENT MANAGEMENT

Grassland management in the AOF is largely informed by general plans, long-term management plans, or individual grazing unit management plans prepared by Network partners or others to address site-specific concerns. Many of the Network partners employ monitoring-based adaptive management approaches that allow for up-to-date research and monitoring results to inform management decisions based on specific goals and objectives. The type, frequency, and extent of grassland monitoring varies between Network partners based on funding, availability, and resources targeted for monitoring. Many monitoring efforts are project-based and are tailored to examine specific metrics of concern (e.g., bare ground, guild cover). These small-scale monitoring efforts are important for site-specific management but may not account for region-wide issues of concern.

The ten-year grassland plant and bird community monitoring conducted by the UC Berkeley Range Lab (Bartolome et al. 2011) was one of the most comprehensive studies of grassland communities in the AOF. The project produced summaries of community change over time and provided range management recommendations for enhancing native plant and grassland bird abundance, managing invasive plant species, and monitoring grazing effects on plant and bird communities.

EBRPD is currently leading a classification and mapping effort covering Alameda and Contra Costa Counties according to the most up-to-date CNPS and CDFW vegetation classification and mapping protocols. The effort is underway and anticipated to conclude in 2024. Associated with this effort, EBRPD is leading a fine-scale grassland mapping effort slated to map approximately 10,000 grassland acres at the lowest feasible classification level (e.g., alliance or association) to complement an existing 2,000 acres of fine-scale mapping recently completed. The classification will be supported by conducting over 200 relevé plots. This effort will directly inform future iterations of this worksheet, as well as management decisions and Network planning.

POTENTIAL FUTURE ACTIONS

- Utilize anticipated fine-scale grassland map to examine plant community patches in terms of relative sizes, as well as inter- and intra-patch dynamics over time and in relation to key wildlife taxa.
- Assess the interaction of grazing levels, thatch, and bare ground on plant communities of concern replicated across subregions.
- Improve understanding and mapping of clay barrens and old growth grasslands within the AOF.
- Develop a consistent set of monitoring methods across Network partners.

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Metric 1: Native grass and forb species cover and/or richness

Studies/Data/Interviews in the Area of Focus:

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- Natural Resource Conservation Service (NRCS). 1935–present. Historic aerial photography exists for the area of focus and can be used to evaluate brush encroachment over time in grasslands.
- Point Blue Conservation Science. 2017. Sunol Regional Wilderness Rangeland Monitoring Results. (This same type of data was also collected on other lands in the Area of Focus, but not on collaborative lands – including Zone 7 and Recology [Altamont landfill])
- San Francisco Public Utilities District (SFPUC). 2009. Alameda Creek Watershed Non-Native Invasive Species Mapping. Prepared by Nomad Ecology.
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- UC Berkeley Range Lab. 2011. EBRPD Grassland Management and Monitoring Options for the East Bay Regional Park District: Final Report (Brushy Peak, Lake Chabot-Fairmont Ridge, Morgan Territory, Pleasanton Ridge, Sunol-Ohlone, Sycamore Valley, and Vasco Caves).
- Walker, M. (HT Harvey and Associates) (consultant to CCWD), J. Scornaienchi (EBMUD ranger), G. Fisher (CCWD grazing tenant), T. DeSilva (CDPR, Carnegie/Tesla). Phone and email interviews in 2019.

Metric 2: Spatial extent of grasslands

Studies/Data/Interviews in the Area of Focus:

- Conservation Lands Network (CLN)/EBRPD. 2020. A vegetation map is being developed by EBRPD, comprised primarily of Conservation Lands Network vegetation cover data. To a lesser degree, the following spatial datasets may be used to refine the vegetation map: East Contra Costa County Habitat Conservation Plan/Natural Communities Conservation Plan (ECCCHCP/NCCP) vegetation cover data, Alameda County Conservation Strategy vegetation cover data, East Bay Municipal Utilities District (EBMUD) vegetation cover data, San Francisco Public Utilities Commission (SFPUC) Alameda Creek vegetation cover data, and Classification and Assessment with Landsat of Visible Ecological Groupings (CALVEG). Other vegetation datasets include East Bay Resource Conservation Investment Strategy (RCIS) (ICF) and Bay Area Greenprint (Greeninfo Network).
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- East Bay Municipal Utilities District. nd. Vegetation Type Mapping Spatial Data.
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- GoogleEarth Pro. 1939. Historical Photography Mosaic for Contra Costa County.
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Metric 3: Patch size

Studies/Data/Interviews in the Area of Focus:

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- Ehrlich, P., and D. Murphy. 1987. Conservation Lessons from Long-Term Studies on Checkerspot Butterflies. *Conservation Biology*. 1(2). Available at: <https://people.ucsc.edu/~cwilmers/ENVS220/ehrllich1987.pdf>
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- East Contra Costa County Habitat Conservancy. 2014. Vegetation Type Mapping Spatial Data.
- East Bay Municipal Utilities District. nd. Vegetation Type Mapping Spatial Data.
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- High resolution aerial photography (various years and sources).

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METHODS

Landscape Unit Delineation:

The landscape units delineated for **Appendix A** (“grassland landscape units”) include units that are broadly based on the original CLN units used by other worksheets in this assessment (“Network landscape units”). Key differences include: 1) Network landscape units are limited to East Bay Hills (North, Middle, and South), Mount Hamilton Range, and Mount Diablo Range while grassland landscape units also include San Joaquin, Delta, Bayside, Inland Alluvial, and Bay Alluvial; 2) The San Joaquin grassland unit covers a larger area, including portions of the Network Mount Diablo Range unit; and 3) Some relatively minor boundary variations between the Network and grassland landscape units exist primarily due to using drainages instead of highways as boundaries and from using different scales for topographical delineation.

The grassland landscape units were primarily based on units described by the CLN (2011) as well as a draft set of landscape units to be included in an updated Mount Diablo Flora (MDF; Bartosh pers. com. 2020). Additional adjustments were made to reflect local topography, vegetation signatures, hydrology, and geology. The AOF is primarily limited to land within Alameda and Contra Costa Counties with some expansions into adjacent counties to accommodate partner land boundaries.

Boundaries were delineated at a 1:48,000 scale, using the MDF boundaries, CLN landscape units (CLN 2011), USGS geology layers (Dibblee and Minch 2006a and 2006b), CLN specialized geology layer (CLN 2011), USGS 10-meter Digital Elevation Model grids, and multiple aerial images from ESRI and Google Earth. An earlier draft of this worksheet included only four landscape units: East Bay Hills, Mount Hamilton, Mount Diablo, and San Joaquin. Four additional units, Bayside, Inland Alluvial, Bay Alluvial, and Delta, were added to cover all areas with EBRPD lands. Minor updates were made to boundaries during that revision to clarify boundaries with the new units, primarily distinguishing the shift between hilly topography and alluvial flats. Another adjustment shifted a small portion of the San Joaquin-Mount Diablo unit boundary to align with Mountain House Creek. The Altamont Pass area, from Brushy Peak to Los Vaqueros Reservoir to south of Highway 680, is intermediate between the San Joaquin and Mount Diablo units in terms of woody vegetation cover, topography, and geologic formation. Various boundaries for this area may be appropriate, emphasizing different key characteristics. Boundaries for each landscape unit are described below and depicted in **Figure 1** in the Background section.

Bayside – The Bayside unit consists of the alluvial lands and scattered older geologic remnant landforms emerging from the depositional plain (e.g., Miller Knox and Coyote Hills Regional Parks). The western and northern unit boundaries follow the water’s edge visible on aerial photography. The eastern boundary, shared with the East Bay Hills and Mount Hamilton Range units, follows the topographical shift from alluvial flats to hilly terrain. The southern boundary occurs at the Alameda County boundary; however, the landscape unit could continue to wrap around the bay. The Bayside unit captures the Contra Costa and Alameda Urban CLN landscape units, as well as the marshlands of

the SF Bay and Baylands CLN unit. The upland and tidal marshlands intergrade within this unit and margins are expected to continue shifting in the future.

East Bay Hills – The western boundary of the East Bay Hills unit is delineated by the uplifted hill terrain out of the Bayside alluvial plain, which coincides with the Hayward fault. The unit extends to the bay shoreline to the north, encompasses the uplifted topography out of younger Quaternary alluvium to the east, and terminates at Alameda Creek to the south. This unit generally includes the North, Middle, and South East Bay Hills outlined by CLN, with a slight adjustment of the southern boundary to follow Alameda Creek instead of Highway 680.

Bay Alluvial – The Bay Alluvial unit encompasses the recent alluvial deposition between the Mount Diablo unit to the east and East Bay Hills unit to the west. The unit extends to the delta shores to the north. The alluvial area expands westward to include the Martinez shoreline, capturing the flat lands behind the northernmost extent of the East Bay Hills unit. The Bay Alluvial unit also wraps around the northernmost extent of the Mount Diablo unit. The transition between the Bay Alluvial and Delta units is not as distinct here due to the lack of clear topographical, plant community, or geological divisions. The Bay Alluvial unit includes two CLN units: both the primarily urban North Contra Costa Valley unit and tidal marshlands of the SF Bay and Baylands CLN units. As with the Bayside landscape unit, the Bay Alluvial landscape unit incorporates the dynamic marsh and alluvial plain uplands.

Mount Diablo – The Mount Diablo unit is delineated by uplifted topography out of alluvial valleys to the northwest, west, and southwest. The northeastern edge includes higher woody vegetation to the west, excluding lower precipitation levels and elevations to the north and east (Bartosh pers. com. 2020). At Los Vaqueros Reservoir, the unit boundary continues southeast along the geologic boundary between Late Cretaceous sandstone to the east and clay shale and siltstone to the west (Jennings 1977, Dibblee and Minch 2006a and 2006b). This boundary also captures an area with higher precipitation and productivity than the San Joaquin unit to the east. This generally aligns with the CLN Mount Diablo unit.

Inland Alluvial – The Inland Alluvial landscape unit is similar to the Tri-Valley CLN landscape unit and encompasses the recent Quaternary alluvial depositions within the valley between the East Bay Hills to the west, Mount Hamilton to the south, San Joaquin to the east, and Mount Diablo to the north. The boundaries are delineated along the major topographical shift between alluvial valley and hillslopes, as discussed in greater detail in each of the other landscape unit descriptions.

Mount Hamilton Range – The Mount Hamilton Range unit is bounded by the Bayside Alluvial landscape unit to the west. The northern boundary extends to Alameda Creek and along the edge of uplifted hilly topography out of the Livermore (Inland Alluvial) Valley. Although the southern boundary largely follows the Alameda and San Joaquin County boundaries in the south, the Mount Hamilton Range unit continues south beyond the Alameda County boundary to accommodate partner lands. The extension continues south along the Hayward Fault, delineating the hilly topography along the western

extent. The unit ends arbitrarily at Penitencia Creek to the south in order to accommodate partner lands, and then cuts back northward to the county boundary. The southern boundary in the Mount Hamilton Range unit would continue southeast, similar to the CLN boundary, capturing areas with consistent geologic, topographic, and vegetative characteristics. The northeastern boundary follows the division between higher woody cover to the southeast (Mount Hamilton Range unit) and higher grassland cover to the northwest (San Joaquin unit). The CLN boundary continues north to Highway 580 and does not include a separate San Joaquin or similar landscape unit for the eastern interior range adjacent to the delta.

San Joaquin – The northern and eastern boundaries of the San Joaquin unit follow the hilly topography and older geologic forms rising out of the Delta and alluvial lands. The southwestern unit boundary ends at the Mount Hamilton Range unit, along the divide between higher and lower woody vegetation cover. The delineated area between the Mount Hamilton Range unit also follows a geological divide between Jurassic to Cretaceous mélangé to the east (Mount Hamilton Range) and sedimentary rocks to the west (San Joaquin). The unit stops at the San Joaquin County line in the southeast; however, the ecological characteristics of the unit continue to the southeast. The northwestern boundary is shared with Mount Diablo and a very small northern boundary is shared with the Inland Alluvial unit. As discussed for the Mount Diablo unit, the San Joaquin unit is delineated by the woody vegetation signature along the northwest boundary (Bartosh pers. com. 2020) and a geologic division between Los Vaqueros and Mountain House Creek. South of Mountain House Creek, the central portion of the unit extends along the edge of the Interior Alluvial unit. This area has lower woody cover compared to the Mount Diablo and Mount Hamilton Range landscape units, likely due to the lack of a higher elevation interior mountain range to the immediate west, and the resulting lack of orographic precipitation.

Delta – The Delta landscape unit generally aligns with the Contra Costa Delta CLN unit. This unit is bounded by the San Joaquin unit to the east based primarily on a topographical divide between older uplifted geologic blocks and the active alluvial plain. The northern and eastern boundaries are defined by the Contra Costa County boundary, with some accommodations to encompass partner agency boundaries that extend into the Delta.

Grassland Acreage Calculations:

We utilized the modern most recent draft lifeform map from Tukman Geospatial (2023) for all Alameda and Contra Costa Counties and original EHA vegetation data for San Joaquin and Santa Clara Counties to calculate grassland acres within the AOF as well as all EBRPD land within the grassland landscape units developed for this assessment. We first clipped the combined vegetation map to the partner lands layer. Then we unioned the clipped result with the landscape unit, added an acreage field, and calculated acreage. We did a definition query of grassland types of interest, then summarized the resulting acreage by AOF landscape unit. The grassland types of interest were selected with the following definition query "VEG_TYPE" = 'Annual grassland' OR "VEG_TYPE" = 'Moderate Grasslands' OR "VEG_TYPE" = 'Warm Grasslands' OR "VEG_TYPE" = 'Serpentine Grasslands' OR "PUBLISHED_" =

'Herbaceous' OR "VEG_TYPE_1" = 'Moderate Grasslands' OR "VEG_TYPE_1" = 'Serpentine Grasslands' OR "VEG_TYPE_1" = 'Warm Grasslands' OR "VEG_TYPE_1" = 'Annual grassland' (where VEG_TYPE and VEG_TYPE_1 corresponds to EHA vegetation types and PUBLISHED_ indicates Tukman lifeforms).

For the comparison to historical acreage, we first unioned the historical SFEI dataset (Stanford et al. 2011), modern ECCCHCP Vegetation (ECCCHC 2014) and landscape unit boundary, then clipped it to the dissolved AOF boundary. Next, we added an acreage field and calculated acreage for the following classes: current “grassland” class of the “DESCRIPTIO” field and the “Grassland” class of the “Habitat_Ty” field of the historic ECCCHCP dataset, only.

Patch Size Calculations:

We calculated patch sizes on three different spatial layers: 1) modern regional vegetation maps (Tukman Geospatial 2023 and EHA 2023, based on CLN 2011); 2) modern vegetation maps within ECCCHCP boundaries (ECCCHC 2014); and 3) historic vegetation maps within ECCCHCP boundaries (Stanford et al. 2011). Each of these layers was dissolved in GIS to only include the grassland vegetation type. For the CLN dataset, grasslands were considered the types noted in Grassland Acreage Calculations. Notably, the calculations exclude “Alkaline Mixed Grasses,” “Alkaline Flats,” and “Non-Native/Ornamental Grass.” Alkali types were excluded as these were considered wetlands and were not targets for this worksheet iteration. The non-native ornamental grass was also not targeted or of concern for this worksheet. For the ECCCHCP layer, only the “grassland” class of the “DESCRIPTIO” field was used. For the historic ECCCHCP dataset, only the “Grassland” class of the “Habitat_Ty” field was used.

First, we wanted to ensure that intact grassland patches would be considered across AOF partner agency lands. Each of the three vegetation datasets was dissolved by the grassland classes mentioned above into single part polygons. The most recent boundaries of the AOF were dissolved into single part polygons to avoid creating non-ecological boundaries between grasslands that were otherwise contiguous across immediately adjacent partner agency boundaries. We then clipped each grassland layer to the dissolved and edited AOF layer.

Next, we summarized the patches by size. We calculated the acreage of all grassland polygons for each of the three vegetation layers. We then selected all of the grassland polygons that intersected with a given grassland landscape unit (see methodology above for development of this layer). Note that using “intersect” in this case caused a given grassland polygon/patch that spans two landscape units to be counted in both of the landscape unit summaries. We chose to do this in order to more accurately reflect grassland patch size within AOF lands, regardless of external boundaries imposed or overlaid on the grassland. There was considerable overlap between the Mount Diablo and San Joaquin landscape units in the grassland patch size calculations because the landscape unit boundaries are more nuanced. Once the polygons were selected, we calculated the mean polygon/patch size as well as total grassland acres intersecting the landscape unit.

In order to summarize the grassland acres in patches greater than 25 acres, we selected grassland polygons that intersected with a specific landscape unit and were greater than 25 acres.

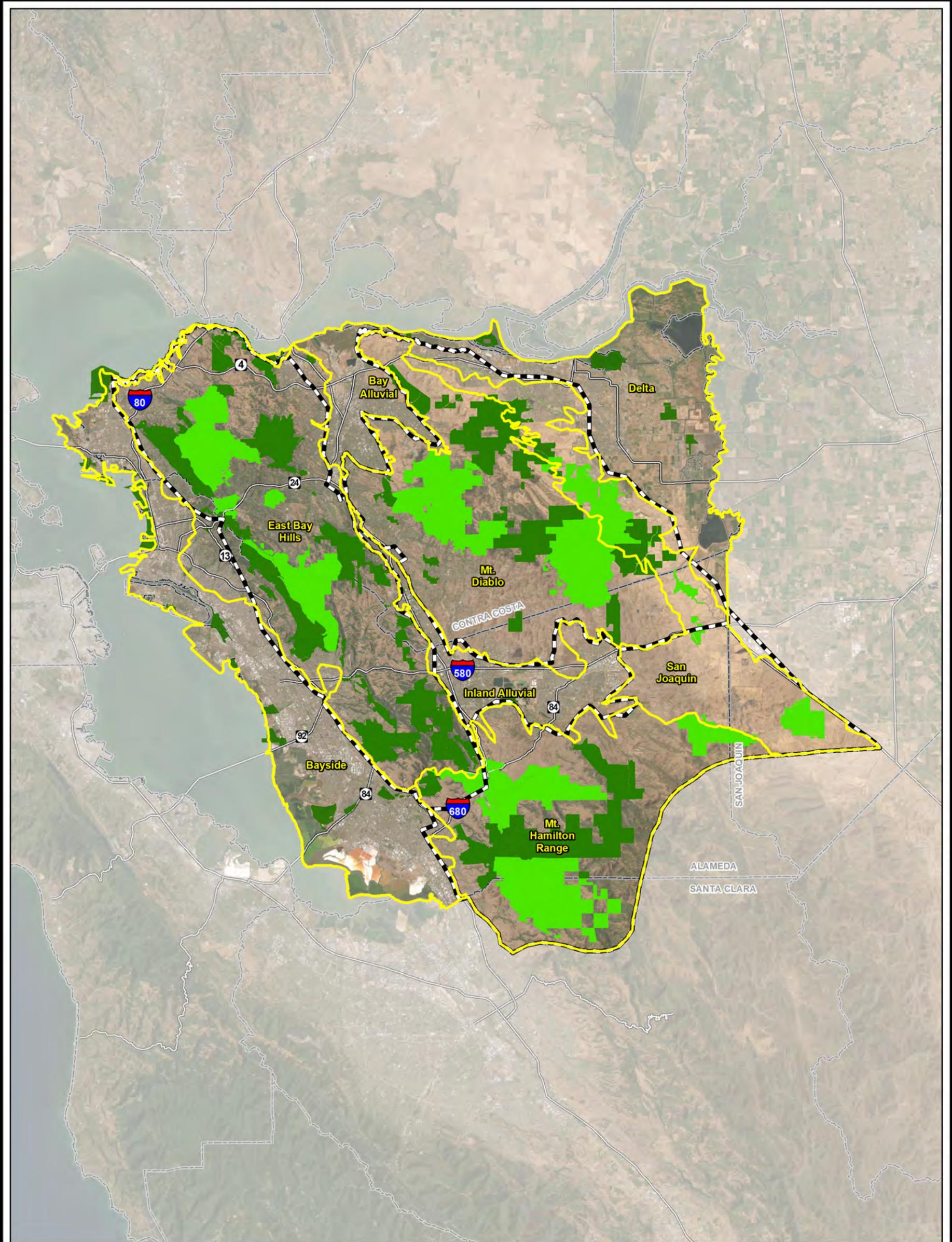
APPENDIX A. ALL EBRPD LANDS

This appendix covers all EBRPD lands, including those which were not included in the partner lands documented in **Figure 1**. Missing lands occurred both within and outside of the AOF. Within the AOF, these lands include properties acquired by EBRPD after partner lands were identified (e.g., Doolan Canyon and Deer Valley). The additional EBRPD lands also cover all EBRPD lands occurring outside the AOF within the Delta, Bayside, Inland Alluvial, and Bay Alluvial grassland landscape units. This section was included to inform EBRPD management actions across all lands based on the analysis in this chapter.

This appendix also covers refined grassland landscape units that include the AOF units and extend beyond to encompass all EBRPD lands (**Figure 2**). The boundaries of the units described in the main document are refined for this appendix. Additional grassland landscape units are Delta, San Joaquin, Inland Alluvial, Bay Alluvial and Bayside. The San Joaquin landscape unit was included in the Mount Diablo and Mount Hamilton landscape units used in the AOF. The remaining units were excluded from the AOF.

Bayside – The Bayside landscape unit is located west of the AOF, extending from the waterfront in the west to the base of the East Bay Hills. The unit encompasses dense urban development, altered stream corridors, and bayfront marsh. The northern end of the unit has the highest frequency of fog cover, lowest maximum temperatures and highest minimum temperatures of the grassland landscape units due to the moderating effects of its location near the San Francisco Bay and Pacific Ocean. The geology primarily consists of alluvial fans, sand, bay mud, and artificial fill with emergent outcrops of older geologic formations, such as Orinda Formation conglomerate, Franciscan mélange, and Franciscan Complex sandstones and shale (Blake et al. 2000, Dibblee and Minch 2005a and 2005b). Some unique geologic formations in the unit include: beach and dune sand (Quaternary), Great Valley complex plutonic rocks (Jurassic), and marine terrace deposits (Pleistocene).

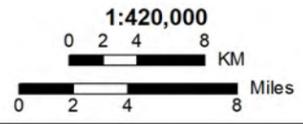
The primary herbaceous plant communities of interest within the Bayside landscape unit include coastal prairie remnants, such as Idaho fescue - California oatgrass grassland (*Festuca idahoensis* – *Danthonia californica*), as well as other more widely documented communities of needle grass - melic grass grassland (*Nassella* spp. – *Melica* spp.) and ashy ryegrass - creeping wildrye turfs (*Leymus cinereus* - *Leymus triticoides*). Many of the western Bayside grasslands in lower elevations intergrade with tidal marshlands and have a higher cover of hydrophytic and saline tolerant plants, such as salt grass. This landscape unit includes Point Pinole, Miller Knox and Coyote Hills Regional Parks.



Legend

-  Highway
-  Additional Partner Land
-  EBRPD Land
-  Grassland Landscape Unit Boundary
-  Area of Focus
-  County Boundary

FIGURE 2.
Grassland Landscape Units, Partner Lands
and Additional EBRPD Lands
 Contra Costa and Alameda Counties,
 California



Note: Landscape Units expand beyond Alameda and Contra Costa County boundaries to accommodate partner boundaries, including EBRPD properties that occur in baylands.



Data Sources: EBRPD/EHA, 2020 | VNLC, 2023
 TIGER, 2000 | Gap, 1998
 GIS/Cartography by R. Foss, 2023
 Document Name: 575_Fig2_EBRPD_B-P_2023-1226

Bay Alluvial – The Bay Alluvial landscape unit covers the north-central Contra Costa alluvial plain which includes the low elevation portions of Martinez, Concord, and Walnut Creek. It is bounded by the East Bay Hills unit to the west, open bay water to the north, and the Mount Diablo unit to the east. The unit is highly developed, with scattered open space areas concentrated along the tidal wetlands to the north. This low-elevation valley has lower precipitation levels and greater temperature extremes compared to the northern end of the Bayside unit but higher precipitation than the Delta and Inland Alluvial units. The relatively higher precipitation levels are due to the moderating influence from the bay to the north and relative proximity to the coast. The unit is centered around the Concord Fault and is dominated by recent surficial Quaternary depositions with a few areas of emergent Eocene and Cretaceous marine sandstone and shale formations. The grasslands in this unit grade from typical valley grasslands upland into tidal marsh communities along the bay fringe. While some rare grassland plants are known to occur in the area, the majority of habitat is degraded and has high cover of non-native plant communities. No grassland plant communities have been formally mapped in the unit. The Bay Alluvial landscape unit includes Martinez Regional Shoreline and Concord Hills Regional Park.

Inland Alluvial – The Inland Alluvial landscape unit consists of the Livermore or Tri-Valley area. As with the other alluvial landscape units, this unit is also highly developed with a few intact grassland areas, which are limited to the outer fringes beyond development centers. The unit is bounded by Mount Diablo to the north, Mount Hamilton to the south, East Bay Hills to the west, and San Joaquin to the east. Farther removed from the coast and bay, the Inland Alluvial landscape unit has lower precipitation and greater temperature extremes than the Bayshore or Bay Alluvial units. Consistent with the other alluvial landscape units, the primary geologic formations are Quaternary alluvium (sand, gravel, and clay) accumulated from the deposition of sediment from the weathering of adjacent hills. The western boundary of the unit coincides with the Dublin and Calaveras faults and associated anticlines and sinclines. The Inland Alluvial grasslands are not well studied but generally consist of disturbed valley grasslands with small areas supporting alkali habitat. EBRPD's Shadow Cliffs Regional Recreation Area and portions of Brushy Peak Regional Park occur within the unit.

San Joaquin – Along with the Delta unit, the San Joaquin landscape unit occurs in the eastern rain shadow of the Diablo and Hamilton units, resulting in the two landscape units having the lowest precipitation levels, highest temperatures, and lowest productivity of the regional landscape units. The San Joaquin landscape unit hosts the majority of the vernal pools found in the AOF, which are generally found within clay flats or in unique rock pools (Witham et al. 2014). Evaporative basins support alkali flats which are transitional between wetland and upland communities. The landscape unit is largely characterized by Great Valley Sequence and recent sedimentary rocks. Unique geology in the unit includes basalt and tuff formations along the northern extent of the unit (Graymer et al. 1996). Observed native plant communities in the unit include California goldfields - dwarf plantain - small fescue flower fields (*Lasthenia californica* - *Plantago erecta* - *Vulpia microstachys*) and tar plant fields (*Centromadia [pungens]*), as well as transitional wetland communities including yerba mansa - Nuttall's sunflower - Nevada goldenrod alkaline wet meadows (*Anemopsis californica* - *Helianthus nuttallii* -

Solidago spectabilis). The landscape unit includes Corral Hollow, managed by Contra Costa Water District (CCWD), and Bethany Reservoir State Recreation Area.

Delta – The Delta landscape unit occurs east of the AOF and is highly influenced by the historic and current hydrology of the San Joaquin-Sacramento Delta. The rainfall and cloud cover are among the lowest of the landscape units, due to the unit’s location within a rain shadow east of the major ridgelines. In areas with a high water table and greater available water, the alluvial soils are highly productive and have been largely converted to agricultural use. The unit is characterized by recent Quaternary deposits associated with the San Joaquin delta, including relict sand dunes that host unique assemblages of herbaceous plant communities. Some of the documented native herbaceous plant communities in the unit include coastal tufted hair grass - meadow barley - California oatgrass meadow (*Deschampsia cespitosa* - *Hordeum brachyantherum* - *Danthonia californica*) and California goldfields - dwarf plantain - small fescue flower fields, as well as transitional wetland communities such as salt grass and alkali sacaton - scratchgrass - alkali cordgrass alkaline wet meadow (*Sporobolus airoides* - *Muhlenbergia asperifolia* - *Spartina gracilis*) alliances. Delta Access and Big Break Shoreline Regional Parks occur within the Delta landscape unit.

Metrics In Detail

The following descriptions and calculations are complementary to the main document’s discussion of the three grassland health metrics. These calculations use the refined grassland landscape unit boundaries and provide information for all EBRPD lands alone and in combination with partner lands. Information is only provided for sections where information regarding grassland landscape units and EBRPD lands is missing from the main document. Baseline, Condition and Trend assessments are not provided for this separate analysis.

Metric 1: Native Grass and Forb Species Cover and/or Richness

Current Baseline:

Additional examples of potential grassland classes, based on MCV alliances, that may be selected for monitoring are listed below for each of the additional grassland landscape units (Sawyer et al. 2009).

- *Bayside*: bunchgrass stands (needle grass - melic grass grassland), mesic flats (ashy ryegrass - creeping wildrye turfs), coastal prairie remnants (coastal tufted hair grass - meadow barley - California oatgrass meadow; Idaho fescue - California oatgrass grassland)
- *Bay Alluvial*: None mapped
- *Inland Alluvial*: None mapped
- *San Joaquin*: forb fields (fiddleneck - phacelia fields, popcorn flower fields), and alkali grasslands (salt grass flats, ashy ryegrass - creeping ryegrass turfs)
- *Delta*: coastal prairie remnants (coastal tufted hair grass - meadow barley - California oatgrass)

Metric 2: Spatial Extent of Grasslands

Current Baseline:

EBRPD manages 54,565 acres of grasslands, based on Tukman Geospatial lifeform data (2023). Combining all EBRPD land and all partner land amounts to over 110,000 acres of grassland. The distribution of grassland acres within the refined grassland landscape units is presented in **Table A-1**.

Table A-1. Grassland Acres Across EBRPD and Partner Lands within Grassland Landscape Units

Grassland Landscape Unit	Approximate Grassland Acres	
	All EBRPD lands	Partner and all EBRPD lands
Bay Alluvial	478	478
Bayside	1,540	1,540
Delta	213	304
East Bay Hills	15,264	22,515
Inland Alluvial	181	181
Mt. Diablo	17,865	32,704
Mt. Hamilton Range	11,807	31,665
San Joaquin	7,216	21,261
Total	54,565	110,654

Trend:

Table A-2 shows the change in grassland acres within the ECCCHC mapped area, and is limited to current EBRPD parks. Across both grassland units, the most grassland acreage was lost to conversion to turf (254 acres) and ruderal (103 acres). All of the turf conversion occurred at Contra Loma and Roddy Ranch (historic golf course in process of restoration), both of which occur in the San Joaquin unit, which accounts for the large percent of grassland lost.

Table A-2. Change in Spatial Extent of Grasslands in EBRPD Lands

Grassland Landscape Unit	Grassland Acres ¹	Historical Grassland Acres ²	Net Percent Grassland Acreage Lost
Mount Diablo	8,728	8,769	0.4%
San Joaquin	6,374	6,809	6%

¹ ECCCHC 2014.

² Stanford et al. 2011.

Table A-3 below shows the change in grassland acres within the ECCCHC mapped area, within all current EBRPD parks and partner lands. The most significant loss of habitat occurred with 1,076 acres converted to the Los Vaqueros Reservoir in the Mount Diablo grassland unit. The two major conversions in the San Joaquin grassland unit were 227 acres to vineyard and 254 acres to turf, which are in the process of being restored. Additional acreage was gained and lost to other vegetation types in both landscape units, likely due to accuracy issues or alternate definitions for vegetation types.

Table A-3. Change in Spatial Extent of Grasslands in EBRPD and Partner Lands

Grassland Landscape Unit	Grassland Acres ¹	Historical Grassland Acres ²	Net Percent Grassland Acreage Lost
Mount Diablo	17,269	18,433	6%
San Joaquin	14,180	14,576	3%

¹ ECCCHC 2014.

² Stanford et al. 2011.

Metric 3: Patch Size

Condition:

The average patch size across all EBRPD lands is 22 acres, which falls in the Caution category. This average is likely lower than the partner patch sizes presented in the main document due to the inclusion of small lands along the bay (Bayside unit) and a reduction due to not allowing grassland patches to extend onto adjacent partner lands from EBRPD lands.

The condition varies by grassland landscape unit. Bay Alluvial, Delta, Inland Alluvial, Mount Diablo and San Joaquin had greater than 25-acre patches. Mount Hamilton Range had between 25 and 15 acres. Bayside and East Bay Hills had less than 15 acres. The relatively high grassland patch sizes of Bay Alluvial and Inland Alluvial were due to intersection with large grassland patches (i.e., Concord Hills and Brushy Peak) occurring primarily in adjacent landscape units. The relatively low patch sizes of the Bayside and East Bay Hills reflect likely brush encroachment issues discussed in the main document. The smaller Mount Hamilton Range patch size is likely due to cutting grass patches to EBRPD borders rather than extending to adjacent partner lands. The patch sizes are smaller in general as this analysis clipped the grassland patches to EBRPD lands rather than the more extensive and adjacent partner lands. See **Table A-4** for patch sizes within all EBRPD lands.

Table A-4. Grassland Patch Size of EBRPD Lands by Grassland Landscape Unit

Grassland Landscape Unit	Average Patch Size (acres) ¹	Condition
Bay Alluvial	180	Good
Bayside	6	Significant Concern
Delta	28	Good
East Bay Hills	12	Significant Concern
Inland Alluvial	101	Good
Mount Diablo	54	Good
Mount Hamilton Range	23	Caution
San Joaquin	485	Good

¹ Tukman Geospatial 2023 and EHA 2023; Note: Grassland patches that occur in two or more landscape units are counted in each landscape unit in order to avoid creating and counting falsely small patches.

Table A-5 presents patch sizes within all EBRPD and partner lands combined. The overall average patch size is 28 acres, in the “Good” category and higher than EBRPD lands alone. The increase in overall average patch size is likely due to inclusion of large contiguous patches across multiple lands. The only difference in condition ratings between the EBRPD only and combined EBRPD and partner lands was an improvement of Mount Hamilton Range to “Good” condition in the combined dataset, likely due to continuity with adjacent lands. The large difference in Delta acreage is due to an intersection with a large patch in the Dublin Hills. The decrease in acreage between the San Joaquin units was due to the increase in the number of small patches on partner lands.

Table A-5. Grassland Patch Size of EBRPD and Partner Lands by Landscape Unit

Grassland Landscape Unit	Average Patch Size (acres) ¹	Condition
Bay Alluvial	180	Good
Bayside	6	Significant Concern
Delta	377	Good
East Bay Hills	13	Significant Concern
Inland Alluvial	127	Good
Mount Diablo	54	Good
Mount Hamilton Range	33	Good
San Joaquin	348	Good

¹ Tukman Geospatial 2023 and EHA 2023; Note: Grassland patches that occur in two or more landscape units are counted in each landscape unit in order to avoid creating and counting falsely small patches.

Trend:

Table A-6 shows the recent and historic average patch size in the eastern Contra Costa area, limited to all EBRPD lands. As with the partner lands, the major decline in grassland patch size appears to be due to increased road density.

Table A-6. Change in Grassland Patch Size Over Time in EBRPD Lands within Portions of Grassland Landscape Units

Grassland Landscape Unit	Average Patch Size (acres) ¹	Average Historical Patch Size (acres) ²
Mount Diablo	71	129
San Joaquin	152	421

¹ ECCCHC 2014; Note: Grassland patches that occur in two or more landscape units are counted in each landscape unit in order to avoid creating and counting falsely small patches.

² Stanford et al. 2011.

Table A-7 below shows the recent and historic average patch size in the eastern Contra Costa area, inclusive of all EBRPD lands and all partner lands. Both average patch sizes are well over the threshold to be considered in good health, although there has been significant decline in patch from historic to present, likely due to increased road density.

Table A-7. Change in Grassland Patch Size Over Time in EBRPD and Partner Lands within Portions of Grassland Landscape Units

Grassland Landscape Unit	Average Patch Size (acres)¹	Average Historical Patch Size (acres)²
Mount Diablo	128	193
San Joaquin	109	478

¹ ECCCHC 2014; Note: Grassland patches that occur in two or more landscape units are counted in each landscape unit in order to avoid creating and counting falsely small patches.

² Stanford et al. 2011.